FORWARD COMPATIBILITY HOOKS
FOR DFS and TPC for WLAN

Claim To Priority Of Provisional Application

5   This application claims priority under 35 U.S.C. § 119(e)(1) of provisional

application serial number 60/448,577, attorney docket number TI-35247PS1, entitled

Forward Compatibility Hooks For 802.11h, filed 02/19/2003, by Lior Ophir.

Background of the Invention

10   1. Field of the Invention

          This invention relates generally to digital communication systems and methods,

and more particularly to a technique of extending the supported channel element, and all

related DFS formats, for the IEEE 802.11 standard.

15   2. Description of the Prior Art

          The IEEE 802.11h standard defines mechanisms for dynamic frequency selection

(DFS) and transmit power control (TPC) that may be used to satisfy regulatory

requirements for operation of wireless LAN (WLAN) in the 5 GHz band in Europe.

Section 11.5, directed to TPC, states "The procedures may also satisfy comparable needs

20   in other regulatory domains and other frequency bands and may be useful for other

purposes, such as interference reduction, range control and power consumption

reduction." Section 11.6, directed to DFS, states "The procedures may also satisfy

comparable needs in other regulatory domains and frequency bands and may be useful

for other purposes." Some definitions however, are currently very specific to the 5 GHz

25   band in Europe, and therefore are difficult to extend.

          In view of the foregoing, it would be both advantageous and beneficial to provide

forward compatibility hooks within 802.11h, so that the same mechanisms can be

employed (with only minor changes/additions) for other regulatory domains, other bands,

30   and/or other purposes.

Summary of the Invention

The present invention is directed to a method of providing forward compatibility hooks within IEEE 802.11h, so that the same mechanisms can be employed (with only

5   minor changes/additions) for other regulatory domains, other bands, and/or other purposes. The current IEEE 802.11h standard defines mechanisms for dynamic frequency selection (DFS) and transmit power control (TPC) that may be used to satisfy regulatory requirements for operation in the 5 GHz band in Europe. The present method provides a format to allow other bands, and relates to the supported channels element,

10   channel switch announcement element, and the Basic/CCA/RPI histogram request/report. The method optionally reserves more than 3-bits in the Basic report (Map subfield). These extensions may be part of 802.11h or any other future standard that enhances the capabilities defined by 802.11h. The extensions may be relevant for example to support DFS and/or TPC for WLAN in the 2.4GHz ISM band.

Brief Description of the Drawings

Other aspects and features of the present invention and many of the attendant advantages of the present invention will be readily appreciated as the invention becomes

5   better understood by reference to the following detailed description when considered in connection with the accompanying drawing figures thereof and wherein:

Figure 1 is a diagram illustrating the current IEEE 802.11h supported channels element format;

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Figure 2 is a diagram illustrating the supported channels element format according to one embodiment of the present invention;

Figure 3 is a diagram illustrating the current IEEE 802.11h channel switch

15   announcement element format;

Figure 4 is a diagram illustrating the channel switch announcement element format according to one embodiment of the present invention;

20   Figure 5 is a diagram illustrating the current IEEE 802.11h basic request format;

Figure 6 is a diagram illustrating a basic request format according to one embodiment of the present invention;

25   Figure 7 is a diagram illustrating the current IEEE 802.11h CCA request format;

Figure 8 is a diagram illustrating a CCA request format according to one embodiment of the present invention;

30   Figure 9 is a diagram illustrating the current IEEE 802.11h RPI histogram request format;

Figure 10 is a diagram illustrating a RPI histogram request format according to one embodiment of the present invention;

5   Figure 11 is a diagram illustrating the current IEEE 802.11h basic response format;

Figure 12 is a diagram illustrating a basic response format according to one embodiment of the present invention;

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Figure 13 is a diagram illustrating the current IEEE 802.11h CCA response format;

Figure 14 is a diagram illustrating a CCA response format according to one 15   embodiment of the present invention;

Figure 15 is a diagram illustrating the current IEEE 802.11h RPI histogram response format;

20   Figure 16 is a diagram illustrating a RPI histogram response format according to one embodiment of the present invention;

Figure 17 is a diagram illustrating the current IEEE 802.11h Basic report (Map field); and

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Figure 18 is a diagram illustrating a Basic report (Map field) according to one embodiment of the present invention.

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While the above-identified drawing figures set forth particular embodiments, other embodiments of the present invention are also contemplated, as noted in the discussion. In all cases, this disclosure presents illustrated embodiments of the present invention by way of representation and not limitation. Numerous other modifications and embodiments can be devised by those skilled in the art which fall within the scope and spirit of the principles of this invention.

Detailed Description of the Preferred Embodiments

The preferred embodiments described herein below are directed to a method of providing forward compatibility hooks within IEEE 802.11h, so that the same

5   mechanisms can be employed (with only minor changes/additions) for other regulatory domains, other bands, and/or other purposes. The current IEEE 802.11h standard defines mechanisms for dynamic frequency selection (DFS) and transmit power control (TPC) that may be used to satisfy regulatory requirements for operation in the 5 GHz band in Europe. The present method provides a format to allow other bands, and relates to the

10   supported channels element, channel switch announcement element, and the Basic/CCA/RPI histogram request/report. The method optionally reserves more than 3-bits in the Basic report (Map subfield).

Looking now at Figure 1, a diagram illustrates the current IEEE 802.11h standard

15   supported channels element 10 format. The supported channels element 10 can be seen to employ a 26 byte supported channels field 12. These bytes are currently used to map 200 channels in the 5 GHz band.

According to one embodiment of the present invention, the same format of the

20   supported channels element can be used in other bands, for example in the 2.4GHz ISM band. In that case the supported channels element 10 employs the same 26 byte supported channels field 12. These bytes are used to map channels in the new band, for example the 2.4GHz band.

25   Figure 2 is a diagram illustrating a supported channels element 14 format according to one embodiment of the present invention. The supported channels element 14 has a "Band Field" 16 that indicates the band to which the supported channels field 12 refers. Most preferably, only the value "5" is allows this field (indicating the 5 GHz) band; while all other values are reserved. Other options also exist for indicating which

30   band is used, for example by numbering different channels in different bands with different indices.

Figure 3 is a diagram illustrating the current IEEE 802.11h standard channel switch announcement element 18 format. The channel switch announcement element 18 has a 1 octet channel number field 20. Although the channel number field 20

5   theoretically may indicate 256 channels, only 200 channels are used in the 5 GHz band.

According to one embodiment of the present invention, the same format of the channel switch announcement element can be used in other bands, for example in the 2.4GHz ISM band. In that case the 1 octet channel number field 20 is used to map

10   channels in the new band, for example the 2.4GHz band.

Figure 4 is a diagram illustrating channel switch announcement element 22 format according to one embodiment of the present invention. The channel switch announcement element 22 includes a "New Band" field 24 (1 octet) indicating the band

15   to which the new channel number field 20 refers.

Figure 5 is a diagram illustrating the current IEEE 802.11h standard basic request 26 format. The basic request 26 format can be seen to use 1 octet for the channel number field 28. Although the channel number field 28 may theoretically indicate 256 channels,

20   only 200 channels are used in the 5 GHz band.

According to one embodiment of the present invention, the same format of the basic request can be used in other bands, for example in the 2.4GHz ISM band. In that case the 1 octet channel number field 28 is used to map channels in the new band, for

25   example the 2.4GHz band.

Figure 6 is a diagram illustrating a basic request 30 format according to one embodiment of the present invention. Basic request 30 can be seen to have a "Band" field 32 that indicates the band to which the channel number field 28 refers. Most

30   preferably, only the value "5" is allowed for this field 30 (indicating the 5 GHz band); while all other values are reserved.

Figure 7 is a diagram illustrating the current IEEE 802.11h standard CCA request 34 format. CCA request 34 uses a single octet for its channel number field 36. Although the channel number field 36 may theoretically indicate 256 channels, this is sufficient

5   since only 200 channels are used in the 5 GHz band.

According to one embodiment of the present invention, the same format of the CCA request can be used in other bands, for example in the 2.4GHz ISM band. In that case the 1 octet channel number field 36 is used to map channels in the new band, for

10   example the 2.4GHz band.

Figure 8 is a diagram illustrating a CCA request 38 format according to one embodiment of the present invention. CCA request 38 can be seen to also include a 1 octet "Band" field 40 indicating the band to which the channel number field 36 refers.

15   Most preferably, only the value "5" is allowed for this field (indicating the 5 GHz band); while all other values are reserved.

Figure 9 is a diagram illustrating the current IEEE 802.11h standard RPI histogram request 42 format. A single octet is used for the channel number field 44 that

20   theoretically may indicate only 256 channels. As stated herein before, this is sufficient since only 200 channels are used in the 5 GHz band.

According to one embodiment of the present invention, the same format of the RPI histogram request can be used in other bands, for example in the 2.4GHz ISM band.

25   In that case the 1 octet channel number field 44 is used to map channels in the new band, for example the 2.4GHz band.

Figure 10 is a diagram illustrating a RPI histogram request 46 format according to one embodiment of the present invention. RPI histogram request 46 has a "Band" field

30   48 indicating the band to which the channel number field 44 refers. Most preferably,

only the value "5" is allowed for this field 42 (indicating the 5 GHz band); while all other values are reserved.

Figure 11 is a diagram illustrating the current IEEE 802.11h standard basic response 50 format. One octet is used for the channel number field 52 that may indicate 256 channels. As already stated above, this is sufficient since only 200 channels are used in the 5 GHz band.

According to one embodiment of the present invention, the same format of the basic response can be used in other bands, for example in the 2.4GHz ISM band. In that case the 1 octet channel number field 52 is used to map channels in the new band, for example the 2.4GHz band.

Figure 12 is a diagram illustrating a basic response 54 format according to one embodiment of the present invention. Basic response 54 includes a 1 octet "Band" field 56 to which the channel number field 52 refers. Most preferably, only the value "5" is allowed for this field 56 (indicating the 5 GHz band); while all other values are reserved.

Figure 13 is a diagram illustrating the current IEEE 802.11h standard CCA response 58 format. One octet is used for the channel number field 60 that may indicate 256 channels (used for 200 channels in the 5 GHz band).

According to one embodiment of the present invention, the same format of the CCA response can be used in other bands, for example in the 2.4GHz ISM band. In that case the 1 octet channel number field 60 is used to map channels in the new band, for example the 2.4GHz band.

Figure 14 is a diagram illustrating a CCA response 62 format according to one embodiment of the present invention. CCA response 62 has a 1 octet "Band" field 64 indicating the band to which the channel number field 60 refers. As with other fields

described herein before, only the value "5" most preferably is allowed for this field 64 (indicating the 5 GHz band); while all other values are reserved.

Figure 15 is a diagram illustrating the current IEEE 802.11h standard RPI

5 histogram response 66 format. One octet is used for the channel number field 68 that may indicate 256 channels (used for 200 channels in the 5 GHz band).

According to one embodiment of the present invention, the same format of the RPI histogram response can be used in other bands, for example in the 2.4GHz ISM

10 band. In that case the 1 octet channel number field 68 is used to map channels in the new band, for example the 2.4GHz band.

Figure 16 is a diagram illustrating a RPI histogram response 70 format according to one embodiment of the present invention. RPI histogram response 70 has a 1 octet

15 "Band" field 72 indicating the band to which the channel number field 68 refers. As with other fields described herein before, only the value "5" most preferably is allowed for this field 72 (indicating the 5 GHz band); while all other values are reserved.

Figure 17 is a diagram illustrating the current IEEE 802.11h standard Basic report

20 (Map field) 74. Five bits are used for indications (BSS 76, OFDM Preamble 78, Unidentified 80, Radar 82, Unmeasured 84); while only 3-bits 86 are left for future indications.

According to one embodiment of the present invention, the same format of the

25 basic report can be used in other bands, for example in the 2.4GHz ISM band. In that case the bits used for indications (76, 78, 80, 82, 84) and the reserved 3 bits 86 can be used for indications in the new band, for example the 2.4GHz band.

Figure 18 is a diagram illustrating a Basic report (Map field) 88 according to one

30 embodiment of the present invention. Basic report (Map field) 88 can be seen to include one more byte 90 in the map field in which all bits in the new byte 90 are reserved.

These bits may be used for new information that becomes relevant when using these mechanisms in <u>other regulatory</u> domains and <u>frequency bands</u> and for <u>other purposes</u>.

5   The present inventor alone recognized the need to extend the supported channel element, and all related formats (DFS ones). The present inventor further recognized that either a "formula approach" or a "table approach" could be employed to implement the extended supported channel element, and all its related formats. The two approaches can be implemented as described herein below.

10   1.   Formula approach: extend the 5MHz*N formula used in the IEEE 802.11h standard, for the new bands. This requires adding negative N's and offsets (different for each band); and recognize that any approach implemented today might need to be changed when new bands are opened.

15   2.   Table approach: define for each band (sub-band, e.g. there might be 3-4 bands in the 5 GHz band including Japan), a table of channel numbers. Then, using the band number and channel number, one can precisely define each frequency, with no problems for offsets; and new bands and frequencies can be added very easily. This approach may require sufficient memory for storing these tables; but if the

20   channel numbers are selected wisely, in a systematic way, the implementation need not hold the table, but instead can use a formula to calculate the frequency based on the band (stored in the associated device), and channel number.

    According to one embodiment, the table approach defines 1) a 2.4 GHz band, that

25   currently allows numbers; 2) a U-NII US (lower, middle, upper) 5 band, that currently allows only the defined channels in the 0-200 range with the 5*N formula; and 3) a Japanese 5 band (inc. 4.9), that uses a 2.5 MHz offset. Optionally, a different split might be: lower 5 (inc. 4.9), upper 5, and the like. It is only important to have enough band IDs to accommodate future needs (different band IDs do not have to be different frequency

30   bands, but also new channel numbers for the same band, as in the Japanese band), and

enough channels. The present inventor believes one byte for band ID and channel numbers 0-255 are sufficient to implement the most preferred embodiments.

In view of the above, it can be seen the present invention presents a significant advancement in the mechanisms for dynamic frequency selection and transmit power control that may be used to provide forward compatibility hooks within IEEE 802.11h. It should be apparent that the present invention represents a significant departure from the prior art in construction and operation. However, while particular embodiments of the present invention have been described herein in detail, it is to be understood that various alterations, modifications and substitutions can be made therein without departing in any way from the spirit and scope of the present invention, as defined in the claims which follow.